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THE CONSERVATION AND UTILIZATION OF OUR NATURAL RESOURCES*

BY JOSEPH HYDE PRATT, STATE GEOLOGIST OF NORTH CAROLINA

Introduction

The two parts of this subject may at first glance seem to be contradictions of each other, but as we stop to analyze the subject and consider it in its broadest sense, we will find that the conservation of our natural resources will mean not only their perpetuation but also that we will be enabled to utilize them perpetually. This can be accomplished by the aid of certain restraining laws which will work little or no hardship on any person or community and the final result will be of the greatest benefit to the State.

This question of the conservation of our natural resources has not sprung up suddenly but has been receiving the serious consideration of our greatest statesmen, scientists and manufacturers. The first direct result of this agitation was the calling together by the President of the United States of a Conference of the Governors of the States and Territories, which met at the White House, May 13, 14 and 15, 1908. The main object of this Conference was stated by the President in his letter of invitation to the Governors:

"It seems to me the time has come for the country to take account of its natural resources and to inquire how long they are likely to last. We are prosperous now; we should not forget that

*The illustrations used in this article have been loaned by the N. C. Geological and Economic Survey and have been used in its various publications.

it will be just as important to our descendants to be prosperous in their time."

That the members of this Conference were interested in this great question is shown by the declaration which was unanimously adopted by them as embodying their conclusions on this question of conservation. Let me quote briefly from this declaration, which will show the attitude of the Governors of the States and Territories of the United States:

"We, the Governors of the States and Territories of the United States of America, in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes and where they laid the foundation of this great nation.

"We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity and happines of the American people *but not to be wasted, deteriorated or needlessly destroyed.*

"We agree that our country's future is involved in this, that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation itself rests.

"We declare our firm conviction that this conservation of our natural resources is a subject of transcendent importance, which should engage unremittingly *the attention of the nation, the States and the people* in earnest cooperation.

"We declare the conviction that in the use of the natural resources our independent States are interdependent and bound together by ties of mutual benefit, responsibility and duties."

This declaration was adopted unanimously by this conference of governors, scientists, jurists and statesmen representing perhaps the greatest body of men that has ever been gathered together in the history of this country. They urged upon the nation and the states to begin at once the conservation of their natural resources. They urged cooperation between the nation and the states and the closing words of the declaration, "and so conserve the foundations of our prosperity" can only be carried out in their entirety by the most liberal cooperation between the states and the nation; and between the states themselves.

The problems relating to the conservation of our natural resources are not local questions but national and state questions. They are questions that are of interest not only to the individual but also to the whole people. Thus, in adopting measures looking toward the conservation of these natural resources, the nation must be considered before the state and the whole people before the individual. Applying this same principle to the state, in any laws that are passed regulating conservation, the whole State must be considered before any county.

As every state is interested in the development of all other states forming the nation, so every part of a state is interested in the development of every other section, for no advancement can be made in one section or county without its being directly or indirectly of benefit to all other sections.

We are all part of the State of North Carolina and we will have to bear our share of whatever praise or disgrace may be meted out to her as a whole or to any part of her. The State's interests extend to the limits of her territory and as North Carolinians, we are interested in her deriving all the benefit possible from the development of her resources whether they be the forests, the swamp lands, and the fish and oysters of eastern North Carolina; the waterpowers, the forests, and minerals of the Piedmont section; or the hardwood forests, minerals, and water powers of the mountain section.

To obtain the most benefit, North Carolina must conserve and at the same time utilize these great natural resources with which she has been so abundantly supplied. To conserve them, they must, as has been stated before, be considered from the standpoint of the State and not from that of the county.

Let us see first what North Carolina's natural resources are. Given in the order of what I consider their importance they are:

1. Soils and products of the soil, as forests, etc.
2. Water Powers.
3. Mineral products, including coals, etc.
4. Products of the sea.

The development of the State is absolutely dependent upon these natural resources. Some of them are of much more impor-

tance than the others and some could perhaps be entirely destroyed (such as fish and oysters) without permanently checking the industrial advancement of the State; but its best advancement is dependent upon the conservation of them all.

When we stop to consider that the population of this country is now increasing about one-fifth of its total number each ten years, we begin to realize how many millions more of people must be fed and clothed from the products of our soil. By the middle of the present century, it is estimated that there will be about 150,000,000 in the United States. This increase is not confined to any one section of the country but there is a decided and steady increase in the population of all the States and Territories. In North Carolina there are now approximately 2,250,000 people but by the middle of this century this population will have increased to approximately 4,600,000. This large growth in population means a constantly increasing drain upon all our natural resources and it is, therefore, time that we as a State and as part of the greatest nation of the world, realize that our responsibility does not rest with providing for the present generation but that we must do our part towards providing for future generations by conserving and perpetuating for their use the great natural resources which we are now ourselves enjoying.

The American people have been called the most extravagant people in the world and, considered from the standpoint of the nation, we are the most extravagant inasmuch as we are extremely wasteful in the production and utilization of our natural resources; and take little thought toward creating a use for what are known as "waste products." It is perhaps not stating it too strongly to say that the wealth of the nation could be nearly doubled if careful consideration were given to the utilization of these waste products and the prevention of waste of the products that are utilized. This includes crops raised by our farmers, soils, forest products, minerals, and fish and oysters.

While this question of conservation is a national one, I wish to consider it principally in its relation to North Carolina and shall take up a discussion of the conservation of the natural resources already referred to and what their conservation will mean to this State.

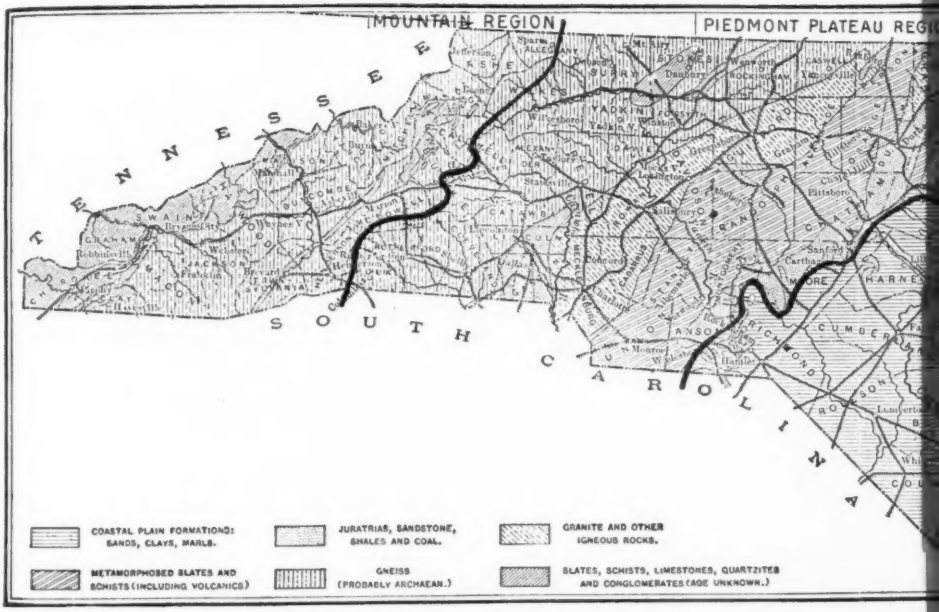
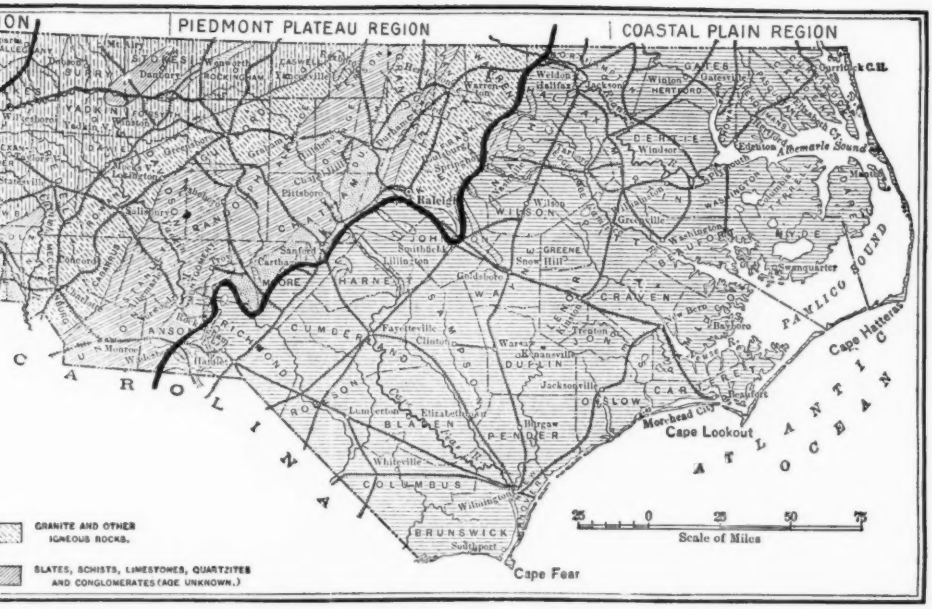

MOUNTAIN REGION
PIEDMONT PLATEAU REGI
TENNESSEE
SOUTH CAROLINA
COASTAL PLAIN FORMATIONS: SANDS, CLAYS, MARLS.
JURATRIAS, SANDSTONE, SHALES AND COAL.
GRANITE AND OTHER IGNEOUS ROCKS.
METAMORPHOSED SLATES AND SCHISTS (INCLUDING VOLCANICS)
GNEISS (PROBABLY ARCHAEAN.)
SLATES, SCHISTS, LIMESTONES, QUARTZITES AND CONGLOMERATES (AGE UNKNOWN.)

PLATE 1. SKETCH MAP OF NORTH CAROLINA SHOWING THE THREE PHYSIOGRAPHIC DIVISIONS AND FORMATION

RTH CAROLINA SHOWING THE THR



THE THREE PHYSIOGRAPHIC DIVISIONS AND THE DISTRIBUTION OF THE PRINCIPAL GEOGRAPHICAL FORMATION

Let us consider briefly the general geographical and geological conditions of the State, as they greatly influence the methods that must be used in conserving our resources. See Plate 1.

As one travels across the State from its eastern shores to its western boundary, it will be noticed that when about half the distance has been passed there is left behind a region which is very level or gently undulating, the surface of which is covered with sand and loam soils from which hard rocks are almost entirely absent; and there is entered another region, the surface of which becomes more and more hilly until it culminates in the high mountains in the western portion of the State, the soil being mingled more or less with hard, granitic, slaty rocks. It will also be noticed that the geological formations of the eastern half of the State are radically different from those of the central portions of the State, which are in turn different from the mountain region.

PHYSIOGRAPHIC DIVISIONS OF NORTH CAROLINA

There are three great physiographic divisions in the State which have been designated as the Coastal Plain, the Piedmont Plateau, and the Mountain region, whose boundaries in a general way are rather sharply defined.

These three physiographic divisions are indicated in a general way on the map, Plate I.

The Coastal Plain region represents the most recent geologic formations composed of gravels, sands, clays and marls arrranged in nearly horizontal layers with the finer material nearer the coast. Along its eastern borders this region contains the sounds and bays, the sand dunes and ridges, the swamps and marshes, and other characteristics of a seashore region. Further inland it is gently undulating and has more of the upland and less of the marsh; towards its western boundary the swamps disappear almost entirely, the upland predominates and the surface becomes more undulating and even hilly in places. The soils toward the east are composed of fine sand and silt, while nearer the western border of the region they contain a larger proportion of coarse sand or gravel mingled with clay. The extent of this region is from Raleigh eastward to the coast, with its western boundaries roughly defined

as extending from the western part of Warren through Franklin, Wake, Cumberland, Chatham, Moore, Montgomery and Anson counties.

Along the western border of the Coastal Plain region there are occasional outcrops of hard granites and slates exposed along the beds of streams, where the once overlying sands and clays have been washed away. In the southeastern counties of this region limestone is exposed at the surface along the banks and streams in a large number of localities. This rock is of such quality that it can in many cases be used for the making of lime, macadamizing roads, and perhaps in some cases for building purposes.

Throughout the entire area of the Coastal Plain region, cotton, corn, oats, sorghum, peas, peanuts, potatoes, especially sweet potatoes, are the staple crops and the culture of tobacco has been introduced with success. Wheat is grown to a considerable extent on the broad lowlands of the Roanoke and in the counties on the north shore of Albemarle Sound; rice has been for a long time a staple crop on the lowlands of the lower Cape Fear; and the upland variety of rice has been introduced with entire success. All the cultivated fruits and berries grow in this Coastal Plain region in great perfection.

The Piedmont Plateau, extending westward from the Coastal Plain region to the mountains, is about 125 miles in width and has an average elevation approximating 900 feet. Crossing the Piedmont Plateau obliquely, are a series of geologic formations which are in general parallel to the mountains and seashore. This section contains undulating lands with many broad valleys and occasionally an isolated mountain ridge or peak. On account of this character of the land, the conservation of the soil is one of the problems of the Piedmont section.

There is a great variety of rocks in this section and consequently the soil of the Piedmont section is very much diversified. This together with favorable climatic conditions, causes this section to have an exceedingly varied range of agricultural products. In this region we find the largest area devoted to the cultivation of the most profitable varieties of tobacco. It is here also that the culture of cotton is more largely extended and pursued and it is in

PLATE 2. CHARACTERISTIC EROSION OF THE MICA RED CLAY AND SILT SOILS. VERTICAL WALL GORGES ARE QUICKLY FORMED IN SOILS OF THIS TYPE WHEN UNDERMINING ONCE BEGINS, AND THE FINAL RESULT IS THE COMPLETE DESTRUCTION OF THE SOIL FOR FARMING PURPOSES.

this region that all the cereals and all the grasses are cultivated to their highest perfection. The fruits of this section are unequalled in excellence, variety and abundance.

It is in this Piedmont Plateau region that the great waterpowers of the State are located and their conservation and utilization will be of the greatest benefit to the State in its general industrial advancement. In this region are also the richest and most valuable of the mineral deposits of the State, the development of which, especially of the clay products and building stones for structural materials, should add very largely to the wealth of the State.

The Mountain region includes the Blue Ridge, Great Smokies, and the country between, which is cut across by numerous cross ranges separated by narrow valleys and deep gorges. The average elevation of this region is about 2,700 feet above the sea level, but the summits of many ridges and peaks are over 5,000 feet. A considerable number of peaks (43) reach a height of 6,000 feet or over, the highest of which is Mount Mitchell with an elevation of 6,711 feet. Over the larger part of this region are to be found the older crystalline rocks, gneisses and granites, probably Archean, which are greatly folded and turned on their edges. On the western and eastern borders of this Mountain region approximately along the line of the Blue Ridge and Great Smokies there are two narrow belts of younger rocks consisting of limestones, shales, and conglomerates and the metamorphosed marbles, quartzites and slates. In this region, as in the Piedmont Plateau, the rocks are decayed to a considerable extent and thus have produced deep soils which vary in character according to the rocks from which they have been derived. The soils are for the most part porous and fertile, affording a luxuriant vegetation, in many places the slopes of the mountains being covered by heavy virgin forests. Where the rocks that have decomposed contain a large percentage of aluminous minerals, a large amount of clay has been formed.

The mountains are covered with a rich soil and the forests extend to their tops. There is no area in any of the other states that is covered with such a variety of timber trees and of such value as are to be found in this mountain region of western North

Carolina. These forests formerly contained extensive areas of walnut, poplar, cherry and tulip trees that had attained a size that would hardly be credited by those who had not seen them. Instead of conserving and perpetuating these valuable trees, they have been ruthlessly cut and logged and are now almost completely exterminated. In general, the cultivated products of this mountain region are similar to those of the Piedmont Plateau region, with the exception of cotton and rice. Two products, however, the Irish potato and cabbage, are grown in this region to a degree of perfection that is hardly excelled anywhere. Of fruits, the apples of the mountain region are widely known for their size and flavor. In the northwestern counties of Ashe, Alleghany, Watauga, Mitchell and Yancey, the conditions are favorable for perfect success in cattle raising.

SOILS

In discussing the conservation of our natural resources, the first that will be taken up will be soils and products of the soil, as forests.

The conservation of the soils and forests stands out preeminently as the most vital duty demanded of us in respect to our natural resources. The nation must be fed and no matter whatever else is given up or destroyed, our food products still remain an absolute necessity and, therefore agriculture really becomes the most important of all human occupations. The worst panic that could be conceived as happening to a nation would be caused by the farmers of the country stopping for but one year the planting and raising of farm products.

Upon the quality and the depth of the soil depends the yield of the farm. With a decrease in the productiveness of the soil, the cost of raising a certain quantity of any kind of produce will increase and this will mean an increase in the cost to the consumer. Thus, both producer and cousumer are very materially affected by the lack of foresight of the producer to keep up the productiveness of his soil to its highest efficiency.

In the early history of the State there may have been some excuse for this, for, with our vast expanse of territory, it was hard

for the people to see or realize the need of seriously considering the question of soil preservation. But, as our population has increased and the productiveness of the soil decreased, the question of soil preservation has become acute.

The first settlers in North Carolina saw in the eastern counties what was apparently an unlimited amount of the most fertile black soil. They considered it inexhaustible, and if the first portion cleared was not perfectly satisfactory, another section would be cleared and the first abandoned. This has also been the principle pursued in respect to the wearing out of the soil. After a certain number of years of constant cultivation, without the addition of any fertilizer, a soil begins to deteriorate and become poor, having given up to the plant certain of its chemical constituents that the plants required for their growth. The old custom has been to abandon such lands and clean up others. This method has also been carried on in the Piedmont and Mountain regions of the State, even up to within the past ten or fifteen years. To-day we are beginning to feel quite seriously the effect of this method of the utilization of our soils.

We have thousands of acres of land scattered throughout North Carolina that are known as "wornout" lands. It is land upon which it is now practically impossible to profitably raise any farm product. These lands not only have had the plant food value almost entirely taken out of the soil but they are in many instances badly eroded and cut into deep gullies, in some instances the entire soil having been washed away (See Plate II). They are really blights on the landscape and very seriously affect the attractiveness of adjacent farms that are in many cases very productive and prosperous.

As can readily be realized from the great variations in the soils of North Carolina, and the great difference in the surface of the land, there must be different methods employed to conserve the soils. Thus, the heavy, red, clayey soils of the undulating Piedmont section will require a decidedly different handling from the heavy, black, loamy soils of eastern North Carolina. In every case consideration must be given to the fact that it is necessary to add to a soil certain chemical constituents in order for it to retain its

fertility. This can be accomplished partly by the rotation of crops and partly by the addition of natural and artificial fertilizers. We have not the time to go into a discussion of this phase of conserving the fertility of the soil, but we can simply state the fact that this is absolutely necessary if the soil is to be kept to its greatest efficiency.

*Erosion of soils.**—In the Coastal Plain region, especially the eastern portion, there is but little difficulty in preventing the soils from being eroded and washed away. This, however, becomes a most serious question in the Piedmont and Mountain regions. To prevent this total destruction of the soil is a serious problem and one to which considerable attention has been given by those interested in the conservation of soils. The effect of this erosion and washing away of our soils, is illustrated in nearly every section of the Piedmont region in the form of gullied farms and areas where the decomposed rocks are exposed and but very little of the soil has been left (See Plate III). There are two methods by which this loss of soil can be very materially lessened and in some instances entirely prevented: First, deeper plowing; and second, terracing. The first applies to all land in the Piedmont and Mountain sections and the second to those steeper areas where it is impossible to hold the soil from washing even by circular and ditch plowing. By terracing (See Plate IV, A and B), however, these steeper slopes can be very effectively kept from washing and the soil preserved. This erosion of the hillside farms of the Piedmont section is one of the greatest drawbacks to successful farming and, while it is possible for one to have a good and productive farm on level land, it requires a man of much greater capacity to operate a farm properly under the adverse conditions which prevail in the Piedmont section where hillside farming is practiced.

Let us consider for a few moments the extent of this erosion and the amount of soil that is annually washed from our farm lands. In this section it amounts to more than 4,000,000 tons per year and this has a value based on the amount of plant food and humus in it of approximately $2,000,000. In the heavy floods of 1908, the estimate was made that 1,500,000 tons of soil

*See Bull. 17 N. C. G. S. Terracing of Farm Lands, by W. W. Ashe.

PLATE 4a. A STEEP SLOPE IN PIEDMONT NORTH CAROLINA THAT HAS BEEN WELL TE RACED. ALTHOUGH THE TERRACES ARE NARROW THEY ARE NEARLY LEVEL A THERE IS BUT SLIGHT EROSION.

PLATE 4b. THESE TERRACES, ALTHOUGH WELL LOCATED, ARE TOO FAR APART, T RISE BETWEEN THEM BEING TOO GREAT. AT LEAST ONE INTERVENING TERRA SHOULD HAVE BEEN CONSTRUCTED.

were washed from the hills of the Piedmont during one week of rain. These figures are based on actual measurements that have been made at various times on some of our rivers as to the amount of sediment carried down by the rivers in a given time. About one-fifth of this solid matter, which causes the muddiness of the waters during a flood, is humus which is washed chiefly from the hillside farms. Estimating this at $2 per ton, which is probably less than it will cost the farmers to replace it, the loss to them in impoverishment of their soils exceeds $500,000. This is a loss which is much underestimated or entirely overlooked by the farmer because it is a loss which takes place so constantly. In the aggregate, however, it is so enormous that it is one of the chief, if not the chief, reason of the poverty of so many of the red clay, hill-side farms.

Lands which are too steep to be readily *terraced* are too steep to be profitably cultivated and, therefore, should not be cleared, but should be kept in forest. If they are already cleared, steps should be taken to re-forest them.

It is possible, even after a land has become very badly eroded, to reclaim it not for agricultural purposes but for forestry purposes.

To be a successful agriculturist or farmer, requires study and thought; and today all those who have taken up this occupation for a livlihood and who are making the most money are those who give thought to seed sellection, rotation of crops, and the fertility and preservation of the soil. There has been too great a tendency to farm too much land; men not realizing that there is more money in farming a small acreage very well than a large acreage poorly. It costs little or no more to raise forty to seventy-five bushels of corn to an acre than it does fifteen, but the profit is very much greater.

FORESTS*

The preservation of our forests, which are one of the natural products of our soils, is one of the most important problems that

*For more detailed information regarding the forests of North Carolina see the following publications of the North Carolina Geological and Economic Survey: Bull. 5, Forests, Lands and Forest Products of Eastern N. C., Bull.

now confronts the State. Before taking up the question of the conservation of the forests, I wish to call attention to the character of these forests and their importance to the State. North Carolina is unequaled in the variety of its hardwoods and conifers by that of any other State or territory. See Plate V. Throughout the whole area of the State the great variety of soils and climate has brought together trees from all parts of Eastern America. There are altogether 153 kinds of woody plants which form a simple upright stem and attain arborescent proportions, growing naturally within the State and of these over 70 are trees of the first size and 57 are trees of great economic value. Plates VI and VII give a good idea of our hardwood and pine forests. Fourteen of these are known to attain in this State a height of over one hundred feet; three of them a height of over one hundred and forty feet; sixteen of them reach diameters of five feet or over; and five, diameters of seven feet or over. There are 24 kinds of oaks found in the State which are three more than occur in any State to the North and two more than are to be found in any State to the South; of the nine hickories known to occur in the United States, eight have been found in North Carolina; here are found all six maples of the Eastern United States, all of the lindens, all six of the American magnolias, three of the birches, eight of the eleven kinds of pines, both species of the hemlock and balsam fir, and three out of the five elms.

The importance of the forests to North Carolina is strikingly shown by the fact that the forests and the industries dependent upon them produce material amounting in value to more than $35,000,000 per year and give employment to 30,000 men. There are but few States in this country where the importance of the forests is relatively as great as in this State where one sixth of the entire wealth-producing capital is invested in forest lands or in industries directly dependent upon the products obtained from the forests. As a State we recognize that our furniture industry is absolutely dependent upon a permanent supply of hardwood; that the tanning industry, if it is to become a permanent one as it should, is dependent upon a constant supply of tanning material,

6. The Timber Trees of N. C., Bull. 7. Forest Fires, Bull. 16. Shade Trees for N. C.; Press Bulletins 14, 15, 16, 17, 18, 20, 22, 24, 25, 27, 28, 30, 34, 36 and 38, which discuss various questions relating to Forestry.

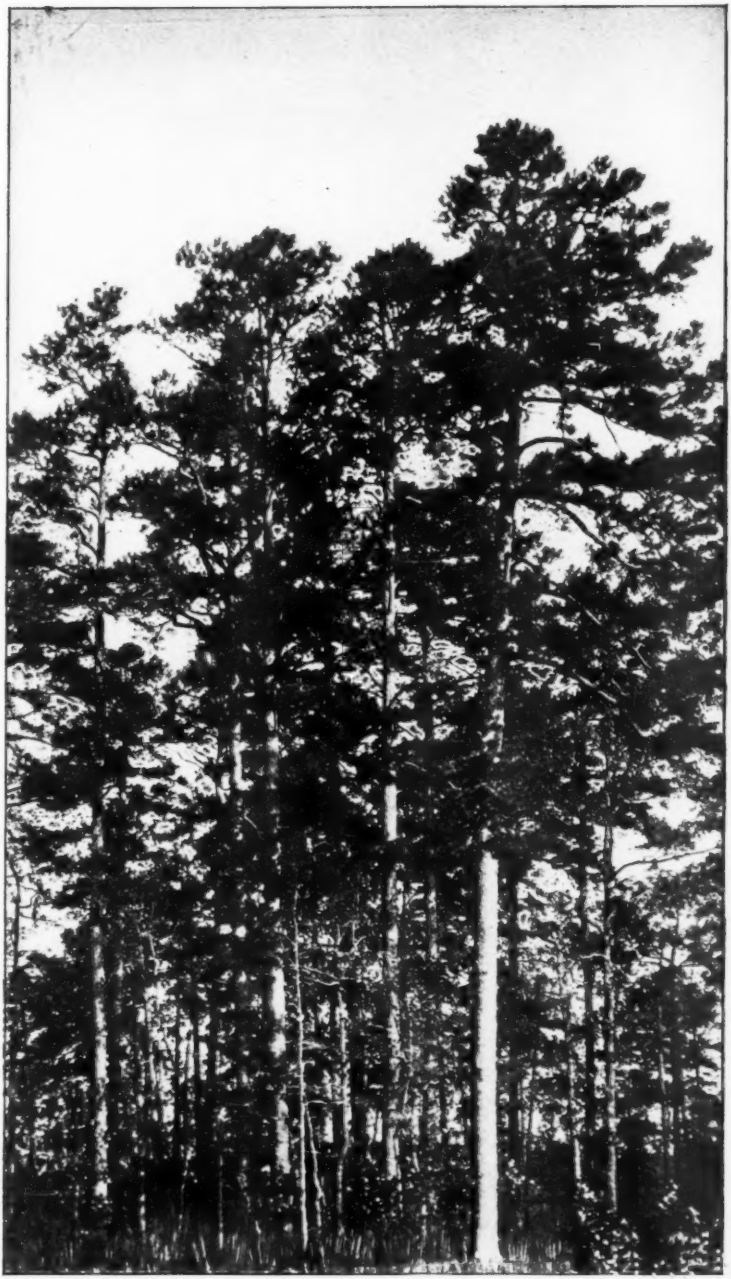


PLATE 5. A MIXED PINE AND HARDWOOD FOREST IN THE PIEDMONT PLATEAU

PLATE 6. A HARDWOOD FOREST IN THE MOUNTAIN REGION OF NORTH CAROLINA.

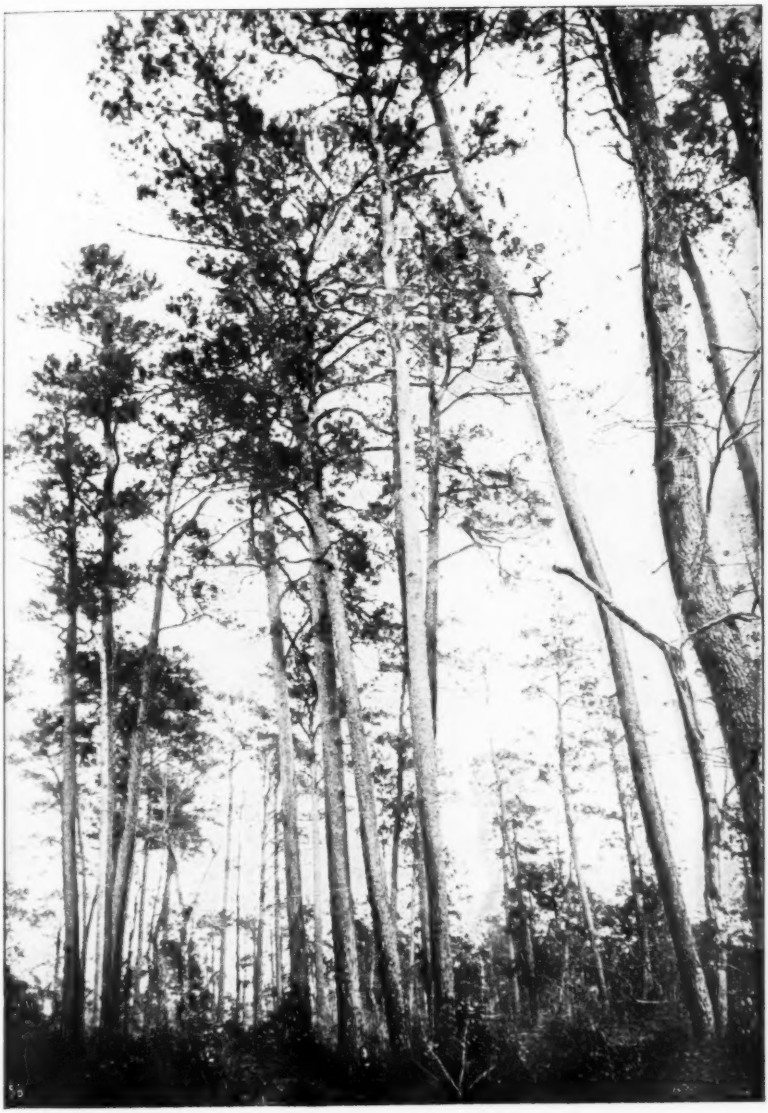


PLATE 7. A LOBLOLLY PINE FOREST IN EASTERN NORTH CAROLINA.

as hemlock and chestnut oak bark; and that the paper industry, which also should be a permanent one, is dependent npon a constant supply of pulp wood. I believe that it is not only possible to make these industries permanent in North Carolina and to give them a constant supply of the various woods that they need, but that it is also possible to develop these to a still greater extent. To do this it is necessary that our forests be conserved and perpetuated.

The forest area of North Carolina covers more than 10,000,000 acres, a very large part of which is steep, rough, or poor land unsuitable for farming purposes. There are also about 2,000,000 acres of waste land in the State which have been lumbered and burned or cleared and found unprofitable to cultivate on account of roughness or erosion, which should be re-forested. With this large area of timber land there was no thought given in the early history of the State to the question of a diminishing supply of forest products. Similarly as in connection with the soils, the people of the State considered they had an inexhaustible supply and therefore gave no thought as to how much they wasted in obtaining what they wanted or how much was destroyed by fire. No care was taken in lumbering to preserve seed trees and make it possible for the land to re-forest itself to the best advantage. In lumbering no plan was considered with the end in view of the forests reproducing themselves with varieties of trees as valuable as the ones removed; or that they would maintain a density so that the soil might produce its full capacity; or of even protecting the timber that still remained: Such methods of lumbering have finally brought us to the place where, according to the State Forester, there are more woody materials used or cut each year in North Carolina than the forests are replacing by the formation of new wood. Then again, each year the forests become less capable of producing what is required of them. Their area contracts, less valuable trees take the place of the more valuable varieties which are cut, the soil becomes more impoverished and less able to yield large returns, and the demand for woody materials gradually increases with the increase in population.

These existing conditions demand that some steps be taken immediately to conserve and perpetuate our forests. This conserva-

tion means for a great many of our citizens a profitable investment; and, in some instances, as the reforestation of abandoned farm lands, it will mean a profitable investment on lands that are now not producing anything of value.

What the great mass of forest lands now needs, however, more than anything else is adequate protection for young growth, for, unless there is young growth and an abundance of it, there can be no trees to take the place of the old ones when they are cut. If there are 200 mature trees on an acre, there should be, if the same area were in young trees three to five years old, five thousand or more trees. Not one-twentieth of the young trees that start to grow can be expected to become large trees. They are of invaluable service, however, in shading the ground and so keeping it moist that the trees may not suffer from drought in dry seasons; in protecting very young seedlings which may be beneath them from excessive heat or sudden changes of temperature which the seedlings of some species cannot stand; and in forcing those trees which do survive to clear their stems by rapidly pushing their tops upward to get the light, leaving behind on the stems only a few small limbs which soon die and drop off, leaving no knots or knot-holes. The litter of their leaves also forms a rich mould which, as it decays, enriches the soil and stimulates the growth of the remaining trees.

In order to accomplish this, a forest must be protected from fire and also from stock. These forest fires are the greatest menance to the perpetuation of our forests. One of the worst effects of the forest fires in eastern North Carolina has been the prevention of the long-leaf pine from reproducing itself. Large areas that were once covered with this valuable tree and which should now be reproducing another growth of the same kind are instead covered with sand oak or blackjack, which are practically valueless. The loss to the people of this section from the burnings of these pine lands, taken in the aggregate, is enormous, as, but for the burnings, thousands of acres which are now denuded of all merchantable trees would either be covered with mature forests or with thick growths of young trees.

The long- leaf pine (See Plate VIII) which was formerly very abundant in the Coastal Plain region of North Carolina, has been

PLATE 8. A LONG-LEAF PINE FOREST IN EASTERN NORTH CAROLINA.

entirely exterminated in certain sections, and the localities where it now grows have been reduced to a very small area. The lands formerly covered with beautiful forests of long-leaf pine are now covered by small scrub oak, sand oak or blackjack oak which are entirely valueless as timber trees. This failure of the long-leaf pine to reproduce itself is due almost entirely to the frequent fires which year after year in the winter and early spring have devastated the pine woods, killing the young pine seedlings. The long-leaf pine only seeds infrequently, a large seed crop growing about once in five to seven years. The seeds are large and nutritious, and when they fall they are eaten in large quantities by hogs, squirrels, and fowls. Then again after the seed has sprouted and rooted, the seedling is of such slow growth that it is three or four years before it begins to form any appreciable stem, all of its energies being used in growing a deep tap root. This tap root is not at all resinous, but is juicy and nutritious and is dug up and eaten by hogs even when the trees are five or six years old. Thus, even if an area escapes burning, practically all of the young trees are eaten by hogs in those sections where there are no stock laws.

That the long-leaf pine will reseed and reproduce itself, if given an opportunity, is well illustrated in New Hanover county where the stock law has been in force for a good many years, and also some attempt has been made to prevent forest fires. In the vicinity of Winter Park on the road from Wilmington to Wrightsville is a good example of land that has been reseeded in long-leaf pine. All along the track of the electric car line on land, whose chief value at present is apparently in the production of timber, there were long-leaf pine seedlings from one year old up, scattered nearly universally through what was once a solid pine forest; but which years ago was logged off and only a few scattered trees left, which, however, have served for seed trees. This young growth was from one inch to eight or ten feet high and in some places dense enough to eventually form a good forest.

With adequate laws, properly enforced, it would be possible to reforest large areas in the Coastal Plain region of North Carolina in long-leaf pine.

In the counties in the middle part of the State fires have done considerable damage in killing down young growth, but, as a gen-

eral thing, except where there are large tracts of forest and the country is poor, rugged or thinly settled, the lands are not regularly burned and the damage that has been done to old trees is much less than in other parts of the State. These occasional fires, however, kill much young growth that has been several years growing and in this way keep the woods open.

In the mountains, although there is a great deal of excellent hardwood timber, many of the trees which would otherwise be merchantable have been badly damaged by fire. The woods have been kept free from young growth by pasturage and frequent burnings. In places they are exceedingly open and there are no young trees at all to take the place of the old ones as they are removed.

WATERPOWERS

The destruction of our forests also has a very serious effect upon the waterpowers of the State. There is, perhaps, no natural resource so valuable to the State in connection with her industrial development as her waterpowers. (Plate IX). In central and western North Carolina there are abundant waterpowers, many of which have been most advantageously developed, while others are still unharnessed. Of all the Southern States, North Carolina stands first in the number and magnitude of her available waterpower and when all factors regarding their development and utilization are considered, there is perhaps no State in the Union equal to North Carolina in this respect. The value of these waterpowers cannot be over-estimated. This refers not only to the very large ones but particularly to the great number of small waterpowers from a few to several hundred horse power each, which are to be found on all the small streams in many parts of central and western North Carolina and which are sufficient for the requirements of some local industry (Plate *X*). They can usually be developed by an individual or company of moderate means and their development and utilization will mean that many small manufacturing establishments will be scattered throughout the State whose operations are independent of any fuel. Many of these waterpowers could not formerly be utilized on account of their location, but now they can be developed and used to advantage by installing at the waterpower an electrical generator and

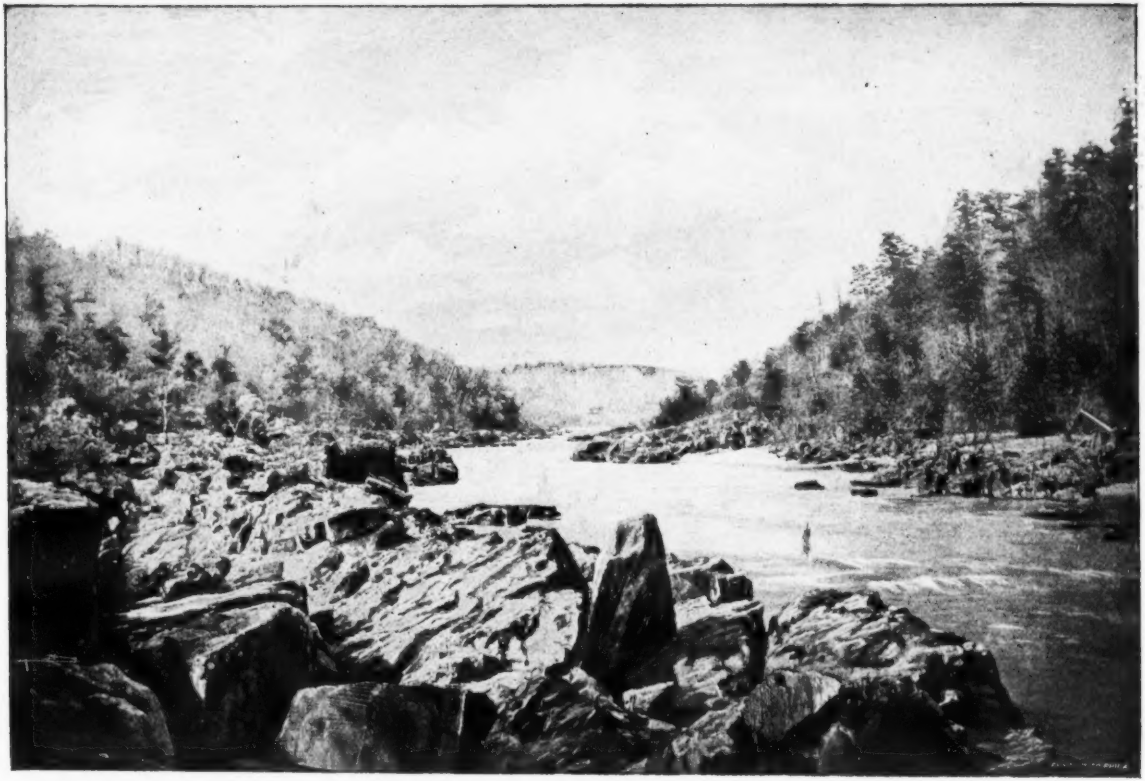


PLATE 9. THE NARROWS OF THE YADKIN, WHICH WILL DEVELOP 30,000 H. P., ONE OF THE LARGER WATER POWERS OF THE PIEDMONT PLATEAU REGION.

PLATE 110. ONE OF THE SMALLER WATER POWERS OF THE MOUNTAIN REGION, CAPABLE OF DEVELOPING 50 TO 100 H. P.

PLATE 110. ONE OF THE SMALLER WATER POWERS OF THE MOUNTAIN REGION, CAPABLE OF DEVELOPING 50 TO 100 H. P.

transmitting electrical power to the point of consumption. There are many towns in North Carolina that are now without electric lights or power which could, at a comparatively small expense, obtain the same by the development of waterpowers that are sufficiently large for the purpose and conveniently located. All such development means that a less amount of coal, wood, and other fuels will be consumed for power purposes.

That these waterpowers should be protected, conserved, and perpetuated is acknowledged by all who have investigated them. One of the most vital influences in the preservation of these water powers is the forests and their most noticeable influence is in mountainous and hilly countries, for they, prevent the soil from being washed away and, by the decay of their leaves, form loam which prevents the water from running off the surface too rapidly. By the removal of the forests there is no longer a protection for the soil on the slopes of the mountains and hills except that produced artificially in the form of ditches, etc. There is no longer a layer or bed of leaves to act as a conserver of the water by absorbing it and preventing its too rapid evaporation and it runs off for the most part as fast as it falls, causing high freshets and floods and periods of extreme low water; causing the streams and rivers to be higher at times of floods but very much lower the greater part of the time than they were before the removal of the forests.

The defects in the water supply are not due to the lack of rain but to the removal of the natural agencies that nature has provided for the storing of this water which has resulted from the removal of the forests. Again, these defects are not due to any considerable extent to the clearing of land for farming purposes for the farmer must of necessity protect the soil from being washed away, and the only loss to the water supply that he would cause would be the greater evaporation to which it would be exposed. They are, however, due to the wasteful and destructive removal of the forests by the lumber companies who leave large tracts of land stript in some cases of every vestige of a tree.

It has been estimated that there are available in the United States 50,000,000 water horsepower, but whether this be 50,000,-

000 or 150,000,000, the fact that it exists today is no guarantee that it will exist 20 years from now unless we as a State and a Nation take the necessary steps to preserve this valuable asset. Simply because we do not desire to avail ourselves of all this water horsepower at the present time does not release us from the obligation of preserving the balance of the waterpower for future generations. There is probably no section in the country where waterpower is not cheaper than steam power, although there are certain places where coal is so cheap that the cost of steam power exceeds little if any the cost of waterpower. In other places, however, the waterpower may be as much as $60 per H.P. cheaper than steam power.

We are using at the present time in the United States not less than 26,000,000 steam horsepowers for manufacturing, lighting, railways, etc. Some of this is so situated that it could not at present be replaced by hydro-electric power; but it has been estimated that ten per cent. would cover all the power that could not be readily replaced with hydro-electric power. This would leave 23,400,000 steam horsepowers that could be replaced by hydro-electric power. The average excess of cost of the steam power as compared with hydro-electric power is at least $12 per H.P. This would make a total of about $281,000,000 that the people of the United States are spending annually for power that is in excess of what is necessary to give them the same amount of power. It also means that we are using up each year a very large amount of our coal resources to develop this power which could just as well be produced by waterpower.

Although at the present time our waterpowers are not being developed to the extent that they should be, yet the amount of hydro-electric power that is being used each year is constantly increasing and the increase in the price of fuel which is bound to come will cause the waterpower development to increase much faster. In studying conservation and its relation to power development, one thing should be taken into account and that is that by proper conservation our waterpowers can be made perpetual and give a constant supply of power: while, on the other hand, when fuel is used to develop the power, it is a constant drain on our

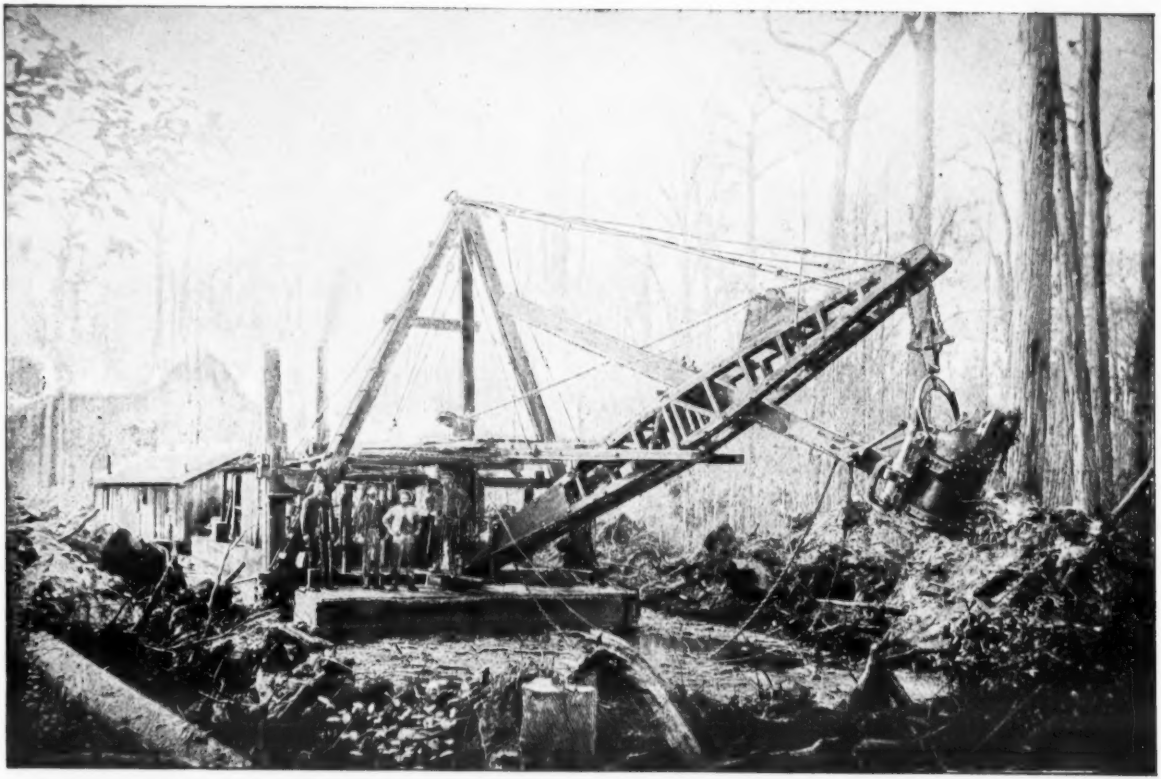


PLATE 12. CHARACTERISTIC SWAMP OF EASTERN NORTH CAROLINA. SHOWING DREDGE AT WORK CUTTING A DRAINAGE CANAL.

fuel resources and the power developed is limited to the amount of fuel used. Thus, every water horsepower developed and utilized means just so much conserving of our fuel resources, which, when once used, cannot be replaced.

MINERAL PRODUCTS

The conservation of the mineral resources of North Carolina is not as serious a problem as it is in many of the States inasmuch as we have no supplies of coal, oil or iron of any great commercial importance at the present time. Of the metal iron, we have deposits of considerable extent which will be available and of large commercial value sometime in the future, but at the present time their isolation from sources of fuel, flux and market are conserving them without any assistance from the State. (See Plate XI) Our structural materials, such as building stones and clay products, as brick, terra cotta. etc., should be developed on a larger scale than they are at the present time, for by their development and utilization we will reduce the drain upon our timber building products. While there is more or less waste in quarrying building stone (See Plate XI.), still many of our companies have found uses for a great deal of what was formerly waste product. Thus, a good deal of the stone that does not make good building material is cut into curbing, into blocks for paving streets, and crushed stone for reinforced cement work, and for macadamizing roads. These products should, therefore, be utilized just as much as possible, and, while we are not in one sense conserving them, we are, as stated above, conserving one of our other natural resources (timber), the drain upon which is now almost equal, if not equal, to the growing capacity of the forests.

SWAMP LANDS

Another line of conservation that I wish to mention briefly is the reclamation of swamp lands. In the western part of the United States the reclamation of these waste lands comes under the head of irrigation, while in the eastern portion of the country it comes under the head of drainage. Irrigation is bringing to land the water that it requires to make it adapted to raising crops while drainage is taking off and away from the land the excessive

amount of water that prevents the land from growing a crop. The Federal Government has already spent many millions of dollars in the reclamation of the dry, arid lands of the West and have been most successful in this work, causing large areas of the desert lands to become flourishing farms. Attention now is being called to the reclamation of our swamp lands and it is considered just as important that such land should be reclaimed as that the arid lands should be watered. We have in North Carolina approximately 4,505 square miles or 2,883,000 acres of swamp lands, besides thousands of acres of overflowed lands, many of which are susceptible to reclamation if properly drained. This area of swamp land in North Carolina is nearly as great as that of the Kingdom of Saxony, which has nearly 5,000,000 people. Thus it is seen that the State has the opportunity of developing an area which is capable of supporting a population that is considerably larger than the population of the whole,State.

The approximate amount of swamp land in 28 of the eastern counties in North Carolina is as follows:

County	Square Miles	County	Square Miles
Beaufort	177	Hyde	387
Bertie	57	Jones	139
Bladen	192	Martin	86
Brunswick	300	New Hanover	25
Camden	162	Onslow	134
Carteret	126	Pamlico	325
Chowan	80	Pasquotank	80
Columbus	300	Pender	370
Craven	238	Perquimans	92
Cumberland	30	Pitt	40
Currituck	40	Robeson	130
Dare	344	Sampson	118
Duplin	125	Tyrrell	251
Gates	45	Washington	262

Total, 4,505 square miles, or 2,883,200 acres.

PLATE 11. GENERAL VIEW OF THE MOUNT AIRY GRANITE QUARRIES SURRY COUNTY, NORTH CAROLINA.

DRAINAGE OF SWAMP LANDS

Considerable work has been done by the Geological and Economic Survey in cooperation with the Drainage Division of the United States Department of Agriculture in investigating:

1. The character of the swamp, whether the soil is suitable for agricultural purposes.

2. Whether the swamps and overflowed lands, where suitable for agricultural purposes, could be profitably drained.

3. Whether the peat deposits contain sufficient quantity of this material and of such quality that it could be marketed.

In making these examinations and in interviews with the people living in this section of the State and interested in the reclamation of these swamp lands, it was found that three obstacles had formerly stood in the way of the drainage of these swamp lands: (1) the cost of clearing the land; (2) the excessive cost of digging adequate canals and ditches to take care of the water; (3) the lack of an adequate law that would permit the carrying out of drainage propositions.

Now, however, all these obstacles have been removed and, wherever the land has sufficient agricultural value to warrant drainage, the drainage propositions can be carried out successfully. Plate XII, shows a swamp in eastern North Carolina, with dredge at work cutting a drainage canal.

The drainage of this vast swamp area would mean not only additional wealth to the State, but it will mean improved roads through large areas that are now almost impassible and inaccessible; the improved roads will mean better school facilities for the children. The drainage of the swamps will also greatly improve the heathfulness of this section of the State.

Of the 3,000,000 acres of swamp land, at least 1,225,000 acres are of sufficient agricultural value to warrant their being drained and are sufficiently elevated above the neighboring water courses to make their drainage a feasible proposition.

The drainage act passed by the State Legislature of 1909 makes it possible to carry out any large drainage proposition, and, as a result of the passage of this aet, there are now 16 drainage dis-

tricts formed or in process of formation, which embrace approximately 350,000 acres.

The fertility of the soil of these swamp lands is unsurpassed, and sufficient work has already been done by soil surveys and the cultivation of the land that has been reclaimed to demonstrate that taken as a whole it is preeminently a corn soil. At the present time, North Carolina produces 2.7 per cent. of the entire corn crop of the United States, but, if these swamp lands were thoroughly drained and properly cultivated, they alone could produce a crop of corn that would be equal to 10 per cent. of that raised in the United States during the past year.

As an illustration of the value of some of our swamp lands after they have been drained, I would like to state what has actually taken place during the past year at one locality in North Carolina. About five miles southeast of Pinetown, Beaufort County, a canal has been constructed through one of our large swamp areas for a distance of five miles and has a width of 30 feet and depth of 7 feet. Before this canal was begun the people living in the vicinity of the swamp all claimed that it would be impossible to drain the swamp, as there was not sufficient fall to take care of the water. The men who were interested in the project, however, had had a survey made of the swamp and were confident that there was sufficient fall along the line of the canal to take care of all the water and drain the land. As the canal was being constructed, it was found necessary at the end of a mile and a few yards to construct a retaining dam six feet high in order to keep sufficient water in the canal to float the dredge. After another mile and a quarter of the canal had been constructed, it was found necessary to build another dam six feet high. After the five miles of canal had been constructed, the total fall in that distance was found to be a little over 12 feet. The dredge was then taken back down the canal and the dams removed. During the extreme heavy rains of the summer of 1908 in eastern North Carolina, this canal was able to take care of all the excess of water, and, as far as I could ascertain, it never rose over 12 inches in the canal. In order to determine the actual agricultural value of the land drained, 10 acres bordering on the canal were

cleared by cutting down the trees and underbrush and burning them, but leaving the stumps. Corn was planted by means of a hand-drill made out of a piece of hollow gum wood. There was no opportunity for plowing the field, so the corn was planted by simply running the drill into the ground and dropping the seed. It was also impossible to cultivate the corn as it was growing, on account of the stumps. The fires, however, had destroyed all of the undergrowth, so that there were no weeds to interfere with the growth of the corn. This tract produced an average of 40 bushels of corn to the acre, and this will give an idea of the great value of this land for agricultural purposes. With the construction of lateral canals this main canal will be capable of of draining from 6,000 to 7,000 acres.

Even the land that is now under cultivation also needs a certain amount of drainage, principally due to the fact that the swamps becoming full of water overflow and saturate the cultivated land with water, so that during the past eight or ten years the farmers have not been able to secure but one good crop in three, with the result that a great many have had to abandon farming. Hyde County, which was formerly known as the granary of eastern North Carolina, was for three years prior to 1909 literally drowned out, but during the latter year there was just the right amount of rain at the right time, so that the crops were excellent. With drainage of the swamp lands of Hyde County, they could be practically assured of a good crop each year, which would mean that this county would be capable of becoming one of the richest counties in the State. Nearly all the other counties in eastern North Carolina have suffered in the same way from lack of drainage; but, operating under the Drainage Act of 1909, these conditions will in a few years be changed and eastern North Carolina will become one of the most prosperous agricultural sections of the country.

In certain portions of these swamps there are deposits of peat which may become sources of a supply of fuel. A small amount of work has been done towards testing these peat deposits, their area and locality, and, while not enough information has thus far been obtained to warrant a definite statement relating to these de-

posits, yet, we do know that there are certain areas, as the peat bog on the outskirts of Elizabeth City, which contain a good quality of peat which could be used as a fuel in the form of briquettes. Some of these peat deposits are located in close proximity to small towns, and it is very probable that it would be practicable to erect an electric plant at the bog using the peat as a fuel, either in the form of briquettes under a boiler, or using the peat directly in a gas producer, and producing electric power which could be transmitted to the town. The utilization of peat in this way would be another means of conserving our other fuel supplies of coal and wood.

FISHING INDUSTRIES

Usually, in discussing the subject of conservation, we are not apt to realize, at first thought, that it applies to the protection and perpetuation of our fish, oysters, and other products of the sea just as much as to the protection of the natural resources of the land.

There is no doubt but that the supply of edible fish, clams and oysters in the waters of North Carolina is becoming less and less each year. There are two facts that are responsible for this condition: (1) insufficient laws for the protection of fish and oysters; (2) non-enforcement of the laws that have been passed.

The falling off in the catch of edible fish is not due to the use of any particular kind of apparatus but to over fishing and the permitting of the fishing of apparatus in places where it ought not to be used. Hundreds and thousands of small fish have been caught, which, if permitted to remain in the water, would in a year or two have become valuable edible fish. The small fish caught in this way are often dumped on the shore and used as fertilizer or shipped to market, with a faint hope that they may be marketable, but often they are thrown out by the dealer. If the small fish are destroyed (by whatever means), it is a self-evident fact that there will soon be a scarcity of large ones, and finally certain fish will become extinct in the waters of North Carolina.

It is possible to protect and perpetuate our fish and oyster industries by the enactment and enforcement of adequate laws. I

believe that the only adequate method of enforcing state laws and fostering our fishing industries is through the operation of a Fish Commission. The work of this commission should be not only to see that the laws are enforced, but it should be able to carry on investigations relating to the various fishing industries; to study local conditions and be able to render a just decision regarding what is the best thing to be done in relation to the perpetuation of the oyster and any type of fish, to the best interests of the state. Up to the present time these questions have been considered locally, while they should be considered as state questions, and the best results can only be obtained when they are thus considered.

The North Carolina Geological and Economic Survey has, and is still, carrying on investigations relating to the protection of the fish and oyster, and to the cultivation of the oyster and clam. The result of this work has been the establishment of a fish commission, but whose jurisdiction, however, is only over a portion of the state; and the passage of an act by the Legislature which makes possible the cultivation of the oyster in North Carolina.

In the investigations relating to the cultivation of the oyster a variety of bottoms as the waters of Pamlico Sound were tested by plants, as at Cunning Harbor, Pains Bay, Long Shoal, Bight of Royal Shoal, and the Junction of Pamlico and Core Sound.

The investigations of the Survey have proved rather conclusively that the cultivation of the oyster is practicable and profitable; and further. that the future of the oyster industry in North Carolina is dependent upon the development of the industry of oyster culture.

THE BROMINATION OF ANTHRANILIC ACID*

BY ALVIN S. WHEELER AND W. M. OATES

The monobromaminnobenzoic acids have been prepared in most cases by the reduction of the bromnitrobenzoic acids in acid solution with tin, zinc or stannous chloride. The 5-bromanthranilic acid was obtained in two other ways by Alt[1] viz., (1) by the oxidation of 5-brom-acettoluide by potassium permanganate and (2) by the bromination of acetanthranilic acid. The latter reaction was conducted in aqueous and in acetic acid solution, the only product isolated being the monobromanthranilic acid. We find that in brominating anthranilic acid direct in acetic acid solution at as low a temperature as possible that one third of the product consists of the 3, 5-dibromanthranilic acid. We[2] find it a most excellent method for preparing both acids. Bogert and Hand[3] employed Alt's methods.

The dibromaminobenzoic acids have been prepared similarly. In addition Wachendorff[4] heated o-nitrotoluene with bromine at 170°. Bogert and Hand[5] prepared 3, 5-dibromanthranilic acid by treating a dilute hydrochloric solution of anthranilic acid with a mixture of potassium bromide and potassium bromate. No yield is given. The few tri- and tetraaminobenzoic acids which have been described were obtained by the action of bromine upon the amines or anil.

We have studied the action of bromine upon anthranilic acid in glacial acetic acid solution, (1) near the freezing point and (2)

*Contribution from the Chemical Laboratory of the University of North Carolina.

1 Alt, Ber. d. Chem. Ges., **22**: 1645. 1889.

2 Wheeler and Oates, Journal American Chemical Society, **31**: 568. 1909.

3 Bogert and Hand, Journal American Chemical Society, **27**: 1476. 1905.

4 Wachendorff, Ann. Chem. (Liebig), **185**: 281.

5 Bogert and Hand, Journal American Chemical Society, **25**: 935. 1903.

near the boiling point of acetic acid. In the first case two thirds of the product consists of the 5-bromanthranilic acid and one third of the 3, 5-dibromanthranilic acid. Under the other conditions the results are reversed almost exactly. The two acids are readily separated by boiling water in which the dibromanthranilic acid is nearly insoluble. The separated acids may be brought upon drying plates within an hour after the preparation is begun.

The monobromanthranilic acid is converted by short boiling with acetic anhydride into the anil and the latter on treatment with water is very rapidly hydrolyzed to bromacetanthranilic acid. Bogert and Hand prepared the anil by boiling the bromacetanthranilic acid with acetic anhydride. We found the barium salt to contain four molecules of water as did Alt. The salt obtained by Bogert and Hand was anhydrous. We have prepared also the silver salt, ethyl ester, 2-chlor-5-brombenzoic acid and its barium salt. The latter acid has only been described by Cohen[1] but he gave no analysis. Our preparation recrystallized from glacial acetic acid gave the melting point stated by Cohen, 155-6°, but we could get no satisfactory analysis. Then on recrystallizing from water we raised the melting point ten degrees. In view of this discrepancy we shall postpone the description until we have made the acid by Cohen's somewhat tedious method. In this paper we also describe the anil and acetyl derivative of the dibromanthranilic acid as well as the silver salt and ethyl ester.

5-Brom-2-aminobenzoic Acid

Brominatian of anthranilic acid below the freezing point of glacial acetic acid. Twenty grams of anthranilic acid were dissolved in 250 cc. glacial acetic acid and cooled below 16°. After 9.5 cc bromine had been run in the reddish color of the liquid persisted. Before this point was reached the mixture had been converted into a thick mush of white glistening crystals, consisting of the hydrobromides of the mono- and dibromanthranilic acids. The product was filtered off, washed with benzene and after drying was found to weigh 54.7 grams. It was then boiled up with 500 cc. water containing 25 cc. concentrated hydrochloric acid and filtered hot

1 Cohen, Journal London Chemical Society, **85**: 1267. 1904.

with suction. The insoluble residue was extracted twice more with 500 cc. boiling water. The filtrates upon cooling yielded abundant precipitates of the monobromanthranilic acid. The insoluble residue consisted of the dibromanthranilic acid, amounting to one third of the product. In the glacial acetic acid filtrate we found a little tribromaniline. We also tried the bromination of the hydrochloride of anthranilic acid in glacial acetic acid and also a hydrochloric acid solution of anthranilic acid but the results were less satisfactory.

Barium 5-brom-2-aminobenzoate. Alt who prepared this salt by boiling the acid with barium carbonate states that it crystallizes with four molecules of water. Bogert and Hand did not obtain this salt but an anhydrous one crystallizing in prisms. We employed Alt's method and obtained the same salt crystallizing in needles and containing four molecules of water. It was impossible to determine the water since the salt began to decompose before the requisite amount of water was expelled. This occurs about 170°.

Calculated for $C_{14}H_{10}O_4N_2Br_2Ba._4H_2O$	Ba. 21.48
Found:	21.78

Silver 5-brom-2-aminobenzoate. The neutral ammonium salt was treated with silver nitrate which caused a dense white precipitate. The salt is anhydrous.

Calculated for $C_7H_5O_2NBrAg$:	Ag. 33.43
Found:	33.69 33.51

Ethyl 5-brom-2-aminobenzoate. The silver salt was boiled with an excess of ethyl iodide. After distilling off the excess the residue was extracted with chloroform. The ester crystallizes from alcohol in yellow needles which melt at 187°.

Calculated for $C_9H_{10}O_2NBr$:	Br. 33.10
Found:	32.79

5-Bromacetanthranil. Bogert and Hand obtained this anil by boiling the 5-bromacetanthranilic acid with acetic anhydride[1]. We obtained it by boiling 4 grams 5-bromanthranilic acid with 40 cc acetic anhydride for 15 minutes. On cooling the solution an abundant crystallization of colorless scales took place. The filtrate contained a mixture of the anil and the acetyl derivative. The

anil is very soluble in hot benzene, alcohol and ligroin but difficulty soluble when cold. It is not readily soluble in ether. It melts at 134°. Bogert gives 131° (corr.). It is instantly hydrolyzed to the bromacetanthranilic acid by hot water. The same result is obtained by boiling with glacial acetic acid,99-100 per cent, for two hours.

Calculated for $C_9H_6O_2NBr$:	C, 45.00	H, 2.50	Br, 33.36
Found:	45.00	2.62	33.40

3,5-Dibrom-2-aminobenzoic Acid.

Bromination of anthranilic acid in boiling glacial acetic acid. Fifty grams of anthranilic acid were dissolved in 500 cc glacial acetic acid and while boiling 27.5 cc bromine were run in. An abundant separation of colorless crystals took place. After cooling the product was filtered off, washed with glacial acetic acid and then with benzene. The weight of the hydrobromides was 116 grams. The mixture was boiled up five times successively with 500 cc water, each filtration being made rapidly with suction. The insoluble residue consisting of the dibromanthranilic acid constituted two thirds of the product. The pure acid was obtained by recrystallizing from alcohol. The melting point was 232° (uncorr.). Bogert and Hand give 235-5.5° (corr.).

3,5-Dibromacetanthranil. Ten grams 3,5-dibromanthranilic acid were boiled 15 minutes with 100 cc acetic anhydride. Upon cooling an abundant mass of long colorless needles were deposited, some being an inch long. The weight was nine grams and the melting point 176°, the substance being pure. On concentrating the filtrate another gram was obtained, melting at 173°.

Calculated for $C_9H_6O_2NBr_2$:	Br. 50.14
Found:	49.99, 49.99

The anil is easily soluble in benzene, glacial acetic acid, chloroform, toluene and fairly soluble in alcohol. It is insoluble in water, cold or hot. Its conversion back to the dibromanthranilic acid is effected by warming in 15 per cent. sodium hydroxide for 15 minutes and neutralizing with acid. A one per cent solution

1. Bogert and Hand, Journal American Chemical Society, **27**: 1484. 1905.

of sodium hydroxide introduces water into the anil giving the dibromacetanthranilic acid.

3,5-Dibromacetanthranilic acid. The free acid was obtained by boiling the anil a moment in dilute sodium hydroxide and immediately acidifying with hydrochloric acid. It is also obtained by long boiling with glacial acetic acid. The crude product melts at 217°. On recrystallizing from alcohol-benzene the melting point is raised to 218-9°. It crystallizes from glacial acetic acid in microscopic needles. It is easily soluble in alcohol and glacial acetic acid. It is insoluble in ether, chloroform, benzene and toluene.

Calculated for $C_9H_7O_3NBr_2$; Br. 47.47
Found: 47.36, 47.42

Silver 3,5-dibrom-2.aminobenzoate. A neutral ammonium salt solution of the acid was treated with silver nitrate. A dense white precipitate was thrown down. This is anhydrous and decomposes about 270°.

Calculated for $C_7H_4O_2NBr_2Ag$: Ag. 26.84
Found: 26.70

Ethyl 3,5-dibrom-2-aminobenzoate. The ester was prepared by boiling the silver salt with excess of ethyl iodide. After distilling off the unused ethyl iodide the residue was extracted with cold chloroform. The chloroform extract on evaporation to dryness left a white but somewhat oily residue. This was recrystallized from alcohol. It forms fan-shaped groups of needles which melt at 74°

Calculated for $C_9H_9O_2NBr_2$: Br. 49.53
Found: 49.34 49.46

Chapel Hill, N. C.
March 19, 1910.

A VISIT TO THE GRAVE OF THOMAS WALTER*

BY W. C. COKER

With Plates 13 and 14

> And Bahram, that great Hunter—the Wild Ass
> Stamps o'er his head, but cannot break his Sleep.

It has been said that one man cannot make an atmosphere, and this is true, but there will sometimes appear a man with so great "a light within his own clear breast" that he looks out upon the obscure world about him with a soul that is illumined.

Such an one was Thomas Walter, "Agricola," and Botanist of South Carolina.

The lack of the historical instinct which is so characteristic of our people, is sadly evident when we look for the life story of this remarkable student of nature. The little that is known of his life has recently been published in one of the interesting series of articles on South Carolina Botanists by Wilson P. Gee in the News and Courier. It is but the barest outline that we have of his career, and no portrait is extant to give us an idea of his personal appearance.

The fragmentary data we have is gathered from a very few sources, the inscription on his grave; the pages of his book (the Flora Caroliniana); the genealogical record of his descendants, and the traditions of his home community. The pamphlet entitled "A Contribution to the History of the Hugenots of South Carolina," by Samuel DuBose and Frederick A. Porcher (being a republication of several papers) contains most of what is known of Walter's life. From this source was obtained also most of the information given below in regard to the history of the Santee section.

From all sources we learn that Walter was born in Hampshire, England, came to South Carolina as a young man, married Miss Sarah Peyre for his first wife and Miss Dolly Cooper for his second, acquired a plantation on the banks of the Santee River, in St. Steven's Parish, and made it his home for the remainder of his life. His house was built within a few feet of the southern

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edge of the wild swamp of the Santee river, and adjoining it he marked out and planted with paternal care, one of the first Botanical Gardens of America. John Bartram, of Philadelphia, had established the first American Botanical Garden about 1730, and Humphrey Marshall had begun his garden, also near Philadelphia, in 1773, about the time, presumably, that Walter was at work on his. These three gardens were the first of their kind in the United States.

But Walter did not confine his botanical interest to his garden. In complete isolation from the scientific world and seeing, so far as we know, no other person that was interested in science except the itinerant collector John Fraser, of London, he began a scientific study of the plants around him and completed, before his untimely death at about forty-eight, one of the most complete and accurate works on American Botany that appeared during the 18th century. This book, the "Flora Caroliniana," was published in London in 1788, at the expense of John Fraser, the collector and seedsman above mentioned, who had gotten the manuscript from walter on one of his earlier visits to South Carolina. The foot of the title page is inscribed as follows:

Londini:
Semptibus J. Fraser:
Prostant venales apud J. Wenman, in vico vulgo dicto Fleet Street
M,DCC,LXXXVIII

The volume, which is written entirely in Latin, contains 263 pages exclusive of the preface of four pages, index, title page, and dedication page. There are 435 genera, and many of the species described were new to science. In spite of the vicissitudes of botanical nomenclature the names that Walter gave his discoveries are still in large measure retained, and the designations of many of the best known and most attractive of South Carolina plants now honor his achievement and commemorate his name.

Such for example, are: Quercus pumila (dwarf oak), Quercus lyrata (overcup oak), Carpinus caroliniana (hornbeam), Pinus glabra (spruce pine), Nyssa biflora (black gum), Acer Carolinia-

num (Carolina red maple), Ilex myrtifolia (myrtle-leaved holly), Ilex decidua (deciduous holly), Lilium Catesbaei (Catesby's lily), and Sarracenia minor (a pitcher plant).

Of the plants that have been named by others for Walter, in appreciation of his scientific attainments, the best known, perhaps, is the beautiful red-berried smilax or cat brier (Smilax Walteri) that is abundant in the swamps of our coastal plain. What more charming memorial could one desire than the lovely wreaths of this cardinal of the woods that brighten the cold swamps with such a glowing flame? Every Christmas, at our home in Hartsville, we go out into the swamp and bring in these brilliant berries to add color to the day.

From the last paragraph of the preface we gather that the plants described in the Flora Caroliniana were all collected within a radius of fifty miles, presumably with Walter's home as a center. The paragraph is as follows:

Stirpes plus mille hoc opere comprehendi mirum fortasse videatur, quum cognitum fuerit vix non omnes collectas fuisse ex area non ampliore quam quae linea bis duplicata quinquaginta millium passum circumscribi potest. Etiam multae adhuc latent ut quotitie docet experientia. Gramina et plantae classi Cryptogamiae appertinentes, plerumq. intacta remanent. Praeterea plures omittuntur arbores, frutices et herbae, quorum fructificatio auctori nondum satis patuit.

Carolinae Meridialis,
ad Ripas Fluvii Santee,
30 Dec. 1787.

After the death of Walter in 1780, his plantation became a part of the estate called Mexico, and was for a long time owned by the Porcher family. It is now the property of the Atlantic Coast Lumber Co. of Georgetown.

The herbarium that Walter made was taken to England by John Fraser and seems to have remained in the Fraser family for a long time. In 1849 it was given to the Linnaean Society and was sold by it to the British Museum. It is now to be found in the Natural History section of the British Museum, South Kensington, London.

In an article on the "Identification of Walter's grasses" in the Annual Report of the Missouri Botanical Garden for 1905, Dr. A. S. Hitchcock says:

"The herbarium suffered before it came into the possession of the Museum and many of Walter's types are missing, especially among the grasses. The plants are mounted in a large book, usually several specimens on a page, the labels being fastened to each plant. The specimens are for the most part very fragmentary, often consisting of a leaf or an inflorescence. When the herbarium was obtained by the Museum, most of the plents were mounted, but a few were loose and have been subsequently mounted at the end, following the others. All the grasses appear in this second part (pp. 112 et seq.). There are 18 specimens of the grasses. In the following notes I have attempted to identify the species of grasses published by Walter in his Flora, considering the specimens in his herbarium, the descriptions, which are often meagre, and tradition as shown by the disposition made of his species by Micheux, Pursh, and Elliott, who worked over the same territory and must have been familiar with Walter's work.

"Walter seems to have followed in his identifications the second edition of Linnaeus' Species Plantarum or the twelfth edition of the Systema, which is about the same. The use of italics for cerspecific names is not clear. Those thus printed appear to be new species, but many of those printed in Roman are also new names. Many of Walter's names as applied to grasses are yet doubtfully identified or entirely unidentified and probably must remain so."

The numerous descendants of Thomas Walter are now represented in several prominent family names, but, as his only son died unmarried, the name of Walter was not perpetuated.

He married first Miss Sarah Peyre, of St. Steven's parish, and one son, Thomas, and two daughters, Ann Peyre and Mary, were born of this union. His second wife was Miss Dorothy Cooper and to her another daughter, Emily, was born. The gifted botanist and physician Dr. Erancis Peyre Porcher, well known as the author of the "Resources of our Southern Fields and For-

ests,'' was a great grandson of Walter's, and from Dr. Walter Peyre Porcher, of Charleston, his son, and Judge Walter G. Charlton, of Savannah, and Mr. John Peyre Thomas, Jr., of Columbia, I have secured the following record of the descendants.

Thomas Walter, Jr., reached maturity, but did not marry, and died before his father.

Mary Walter married Francis Peyre and had three children, Isabella Sarah, Thomas Walter, and Hannah Ashby, the two latter dying unmarried.

Isabella Peyre married Dr. William Porcher and had six children, William E., Francis Peyre (Physician, and author of ''Resources of our Southern Fields and Forests''), Julian H., Louise, Mary, and Alexander.

Dr. Francis Peyre Porcher married Miss Virginia Leigh and had three children, Walter Peyre (Physician, of Charleston), Julia W. (Mrs. T. S. Wickham, of Henrico County, Virginia,) and Virginia L.

Alexander Porcher married Miss Margaret Faber and had one son, Mr. J. Faber Porcher, of Charleston.

Ann Peyre Walter married Mr. Hazel Thomas, of Betaw plantation on the Santee River, and they had issue as follows: Anna Hazell, who died unmarried, John Peyre, Thomas Walter, Edward, Thomas Hazell and Samuel Peyre. Of the sons, all except Thomas Hazell married and left numerous descendants. Colonel John Peyre Thomas, now seventy years old and one of the most distinguished citizens of Columbia, is the son of John Peyre.

Emily Walter married Judge Thomas Usher Pulaski Charlton from the neighborhood of Camden, and had three children, two of whom, Thomas Jackson and Robert Milledge, survived infancy. Dr. Thomas Jackson Charlton married Sarah Waters and had two children, Dr. Thomas Jackson and Ellen St. Leger. This Dr. Thomas J. Charlton married and had several children, among them the present Dr. Thomas J. Charlton of Savannah, who is married and has a son, Thomas J. Jr.

Robert Milledge Charlton married Margaret Sheik, of Savannah and had ten children, of those reaching maturity only the following three have married: Mary Marshal to Julian Hartridge, Mar-

aret to C. P. Hansell, and Walter Glasco (now Judge of the Superior Court, Savannah) to Mary Walton, daughter of Richard Malcom Johnston. All of these have children.

The only published records we have of visits to the home of Thomas Walter, describing the condition of his garden and grave, are by Mr. H. W. Ravenal, the famous botanist, in the Proceedings of the Elliott Society, Vol. I, page 53 (quoted by Mr. Gee, in his article above mentioned), and by Prof. Ezra Brainerd in the Bulletin of the Charleston Museum, Vol. 3, p. 33, April 1907. Mr. Ravenal could find very little trace of the garden—two clusters of the tallow tree of China, (Stillingia sebifera) and "one or two other things, were the only memorials left of his botanical garden." Prof. Brainard found nothing at all that seemed to have been planted by hand.

I had long felt a "motion of love" to see the spot where Thomas Walter lived and died, and as nothing had been heard of the condition of the place for several years I took an opportunity in August of last year and carried out the long planned trip.

Arriving at St. Stevens from Charleston in the evening I made arrangements with Mr. W. F. Boykin for a conveyance, and made an early start with him the next morning for Pineville, six miles away. The road passed through flat, sandy, pine woods, an occasional low bog, and much good farming land. Close at hand towards the north stretched the broad swamp of the Santee river, five miles wide in places. In the old days before the Revolution when the up country was still an untouched wilderness this swamp was cleared and cultivated in corn and indigo for a distance of at least 10 miles west of St Stevens. Within this swamp at that time were five thousand negro slaves, and on the low bluffs along the southern edge of the swamp there were scattered the comfortable dwellings of the planters. Here wealth and refinement established themselves, and upper St. Stevens and St. John's became the seat of one of the most cultivated and prosperous societies of the state. Now all is changed. The dark days began by the breaking upon the people of the frightful storm of the revolution. No other part of the country suffered more

from the ravages of a destructive war. The internecine character of the struggle is well illustrated by the fact that after the battle of Black Mingo Charles and Thomas Peyre, the brothers of the wife of Thomas Walter, were captured as tories by General Francis Marion—a near neighbor—and sent on foot to be jailed in Philadelphia. The sufferings of Marion's men are well known, the misfortunes of the Tories were equally severe.

Impoverished by the war the planter's families found little hope before them. The loss of England's bounty of sixpence a pound on indigo put an end almort immediately to the planting of that crop; and to add to the miseries of the people the Santee river, about 1790, began to be subject to disastrous floods that destroyed the magnificent crops of the rich swamps and drove the planters to give them up once more to the wilderness. They have never again been cleared.

The introduction of cotton as a profitable crop by the invention of the saw gin in 1794 was a most timely and present help in trouble, and saved the country from complete impoverishment. A large number of fine plantations along the south side of the Santee from St. Steven's to Eutawville soon gained a fair measure of prosperity. Until about 1794 the propietors lived on their plantations throughout the year, but after that they got together and established the town of Pineville where they built their summer homes. At the time of its geatest prosperity the village contained about 60 houses, supported a fine academy, and was the center of a community that reflected all that was best of simplicity, hospitality and culture in southern life before the war.

When I passed through the village on that Sunday morning last August no trace was to be seen of the life of the old days. But three or four houses remained—remained only to mark the backward swing of the inconstant pendulum of time.

From Pineville we drove on to the club-house of the Oakland Gun Club, where we ate our lunch and with fresh horses took to the saddle for the remaining distance. After about a mile through the barrens we came to Belle Isle, one of the old plantations of the Marion family. In a fine grove at the end of an avenue stands the old house, with smoke house and kitchen of

substantial brick in the rear. It is difficult to imagine a more depressing spectacle than the one that met us here. The house, once the focus of the abounding life and hospitality of a famous estate, is now fast falling into ruin. The steps are gone, the ceiling of the piazza is down at one end, and the roof broken through in several places. As I entered the house and picked my way over the insecure floor to it's dark central passages I was startled by the sudden falling of clouds of bats that squeaked and circled about me.

About one hundred feet west of the house is the old family burying ground. Here are the graves of General Francis Marion and his wife. Over the former the General assembly of South Carolina has erected a substantial memorial of granite with a tablet of bronze (see the accompanying photograph, Pl. XIII). Through correspondence with Mr. John Henry Porcher of Bonneau, who has an extensive knowledge of the history of this section, I learn that, contrary to the impression of many, General Marion never lived at Belle Isle. He was born on his father's plantation, Pond Bluff, near Eutaw Spings (now Eutawville), and lived there most of his life. He did live for a time before the revolution at Burnt Savanna Plantation, which immediately adjoined Belle Isle on the west and is now a part of it.

Moving on to the west from Belle Isle we passed a few fields cultivated by negroes and were soon in the heart of as wild a country as is to be found in the state. Broad stretches of thick pine woods, dense canebrakes and impenetrable bogs surrounded us, and to the north extended for miles the great, deep swamp of the Santee. Here is the paradise of the wild things. Hardly a hundred yards was passed without fresh signs of deer. There are said to be more of these and of bear, turkey and wild cat here than in any other section of the state.

After covering about four miles more we arrived at the old Santee Canal, finished in 1800, at an immense cost, and once filled with boats, lined with fine plantations, and resounding with the songs of negroes—now passing through an almost trackless forest and abandoned to decay. The massive masonry work of the locks of this canal is of brick that is said to have been imported from

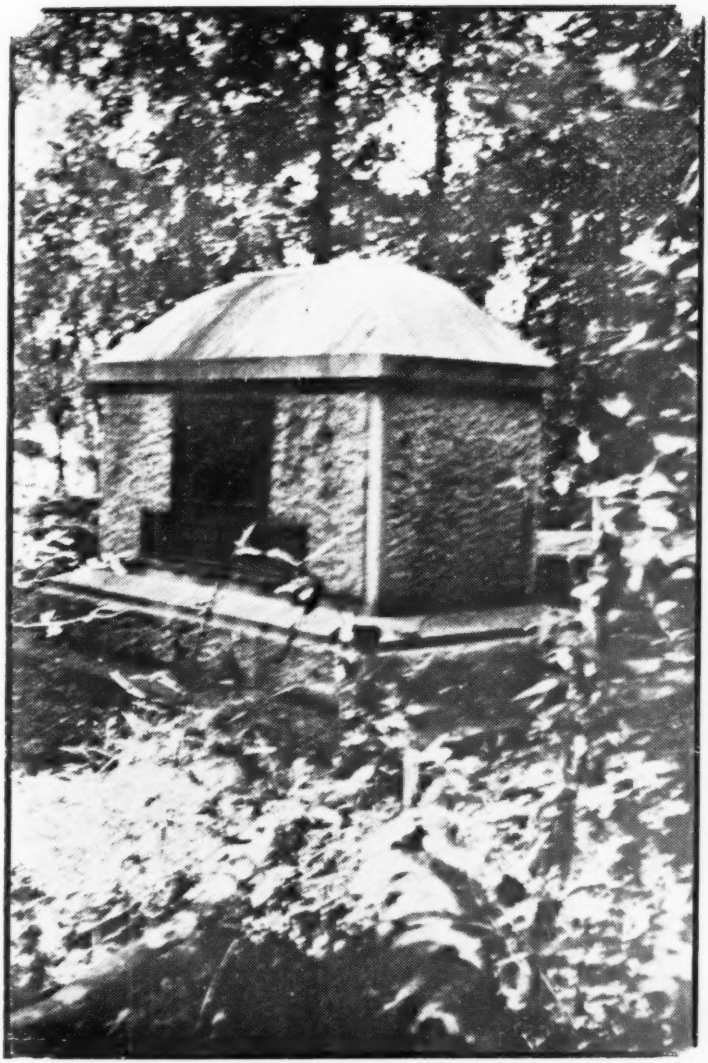

Plate 13—Grave of Gen. Frances Marion

U of M

England. The remarkable preservation of much of this masonry after the ravages of over a century of neglect is an evidence of the thoroughness and honest workmanship that was characteristic of the times.

On examining one of the most perfect of these locks there was noted on the east wall a thick fringe of the exotic-looking fern, Pteris serrulata, a native of China that is now naturalized in the extreme southern states. This is, I believe, the farthest north that it has been found. The only other fern on the lock was the ebony spleenwort (Asplenium platyneuron). On the west wall was an equally luxurient mass of the very attractive southern vine, Decumaria barbara. This vine is characteristic of the coastal region. It extends up as far as Darlington County, but does not quite reach Hartsville.

The horses were urged through the water and sticky mud of the canal with difficulty and passing on for a short distance we came suddenly to a clearing where the trees had recently been logged. The river current sweeping through the swamp towards the south presses up here to the front of some high bluffs. At this point is standing the base af a massive chimney and parts of heavy machinery are lying around, said to be the remains of one of the old pumping stations of the canal.

Mr. Boykin went off to the south to find an old negro, who ffnally arrived and led me a half mile farther up the river which had agair bent away into the swamp. Here about one hundred feet from the edge of the swamp are standing two fine old willow oaks and at the foot of one of these is the grave of Thomas Walter. It is covered with a flat stone, now broken in two and though dotted with lichens and stained and corroded by time the inscription may still be deciphered. As there are several mistakes in the inscription as published by Ravenel and republished by Sargent and Gee I give it below just as it appears on the stone:*

*The best copy of the inscription is that accompanying Prof. Brainerd's article. In lettering and arrangement it is quite accurate, but I find that it differs in three words from my copy as given above.

In Memory
of
THOMAS WALTER
Native of Hampshire in England
and many years a resident of this
State. He died in the beginning of
the year 1788 aetatis cir. 48 ann.
To a mind liberally endowed
by nature and refined by a liberal
education he added a taste to
the study of Natural History
and in the department of
Botany science is much
indebted to his labors.
At his desire he was buried on
this spot once the garden in
which were cultivated most
of the plants of his
FLORA CAROLINIANA.
From motives of filial affection
his only surviving Children
ANN and MARY
have placed this memorial.

It was hard to believe that on this spot was one of the first Botanical gardens of America, planted and tended with loving care by the man who lay at our feet; that in this deserted place was kindled one of the first fires on the alter of Science in the new world.

I looked about me for those traces of the garden that Ravenel had mentioned more than fifty years ago. Not one remained. No Stellingia or any other thing except the wildest growth of the forest. Leaning over the grave was the southern buckthorn, (Bumelia lyciodes), deciduous holly (Ilex decidua), arrow wood (Viburnum dentatum) and red ash (Fraxinus pennsylvanica). From their branches hung Virginia Creeper (Ampelopsis quinquefolia), poison ivy (Rhus radicans), Carolina moonseed (Cebatha Carolina), Cat-brier (Smilax Bona-nox) and Trachelospermum

Plate 14—Grave of Thomas Walter

difforme, a vine that was discovered by Walter himself. The only flowers that were immediately about the grave were Salvia lyrata (in fruit), Oxalis colorea and a large false fox-glove (Dasytoma bignoniiflora) that does not seem to have been found in the state before I saw it here. The ancient oak at the head of the stone was heavily draped with the long grey moss(Tillandsia usneoides), as fitting an emblem of graves as cypress or yew.

Two photographs were taken of the stone—one standing close, the other at a distance of about fifty feet. The latter (Plate XIV) shows well the sad desertion of the spot and the complete encroachment of the forest growth.

Ontside the swamp in the immediate neighborhood of the grave were Pinus taeda, Liquidambar styraciflua, Quercus stellata, Rhus copalina, Myrica cerifera, Celtis crassifolia, Ulmus americana, Hicoria aquatica, Ilex opaca and Cornus stricta.

At a distance not greater than a half mile were collected Malus angustifolia, Styrax americana, Amorpha fruticosa, Azelea nudiflora, Vaccinium australe, Vaccinium fuscatum, Vitis aestivalis, Gaylussacia frondosa, Strophostyles umbellata, Penstemon australis, Lespedeza angustifolia, Meibomia obtusa, Arundinaria tecta, Uniola longifolia, Uniola laxa.

On the way from St. Steven's to Walter's grave the following plants were noticed: Pinus australis, Pinus taeda, Pinus echinata, Pinus serotina, Juniperus virginiana, Quercus virginiana (not common here), Quercus aquatica, quercus tinctoria, Quercus falcata, Quercus Catesbaei, Quercus cinnerea, Quercus marilandica, Quercus pumila, Nyassa sylvatica, Castania pumila, Acer cariolinianum, Liquidambar styraciflua, Fraxinus pennsylvanica, Ilex opaca, Ilex verticillata, Ilex glabra, Ilex corriacea, Ilex myrtifolia, Ulmus americana, Ulmus alata, Diospyros virginica, Platinus occidentalis, Hicoria tomentosa, Cornus florida, Cornus stricta, Taxodium distichum, Salix nigra, Sassafras sassafras, Magnolia glauca, Myrica cerifera, Cyrilla racemiflora, Alnus rugosa, Cephalanthus occidentalis, Callicarpa americana, Rhus toxicodendron, Viburnum dentatum, Pyrus arbutifolia, Ceanothus americanus Clethra alnifolia, Xolisma foliosiflora, Pieris mariana, Gaylussacia dumosa, Chionanthus virginica, Euonimus americanus, Ascyrum stans, Smilax

Walteri, Smilax glauca, Wistaria frutescens, Eupatorium semiserratum, Eupatorium Mohrii. Seriocarpus bifoliatus, Seriocarpus unifolia, Elephantopus tomentosus, Elephantopus carolinianus, Gnaphalium obtusafolium, Hieracium Gronovii, Conoclinum coelestinum, Laciniaria spicata, Chaenolobus undulatus, Chrysopsis graminifolia, Meibomia Dillenii, Lespedeza repens, Lespedeza japonica, Cracca virginiana, Crotolaria Purshii, Chamaecrista nictitans, Apios apios, Rhexia virginica, Rhexia mariana, Rhexia glauca, Breweria trichosanthes, Agrimonia pumila, Koellia hyssopifolia, Sida Elliotti, Mesophaerum rugosum, Oenothera biennis, Boehmeria scabra, Eryngium integrifolium, Septilia, caroliniana, Lilium Catesbaei, Pontederia cordata, Sarracenia minor, Juncus aristulatus, Habenaria Nuttallii (recently reported by me from South Carolina for the first time), Osmuda cinnamomea, Osmunda spectabilis, Woodwardia areolata, Pteris aquilina, Asplenium platyneuron, Eupatorium rotundifolium.

VITALITY OF PINE SEEDS AND THE DELAYED OPENING OF CONES*

BY W. C. COKER

On a visit to California in July, 1908, my curiosity was aroused by the remarkable retention of the still unopened cones in *Pinus attenuata* (*P. tuberculata*) the knob-cone pine, and to a somewhat less conspicuous degree in the Monterey pine (*Pinus radiata*). Trees of *Pinus attenuata* may frequently be seen several feet in diameter and thirty or forty years old, still retaining unopened all the cones they have produced during their lives, the lowest cones circling the tree within hand's reach from the ground. As all cones are borne on new growth it is obvious that as the branches increase in thickness the peduncles of the cones must be broken loose from their connection with the wood, so as to allow the cones to be pushed out by the annual growth, or the cones will be covered as the tree develops and finally imbedded in the wood. As the cones of *P. attenuata* are narrow at the base and othus mre easily caught by the annual layers, the latter alternative sometimes occurs and the cones are covered by the growth of the tree.

The cones that remain on the surface of the trunk and branches have no organic connection with the tree, and their peduncles, which are almost an inch long, may be twisted out like a cork from a bottle. It is a well-known fact that in this case the cones never shed their seeds until the tree or branch that bears them dies.

This remarkable peculiarity is exhibited to almost as great a degree by *Pinus radiata* (Monteoey Pine). Of this tree J. G. Lemmon says†:

*Reprinted from THE AMERICAN NATURALIST, Vol. 43, Nov. 1909.

†*Sierra Club Bulletin*, Vol. 2, p. 74, 1897.

"Trees four and five inches in diameter may be seen on Point Pinos, still retaining every cone they have produced, circling the trunk and limbs from base to apex. Of course the lumber is perforated with holes, the channels formed by the cone-stems on their many years' journey from heart to bark."

Other species of western American pines whose cones are serotinous to a greater or less degree are *P. muricata*, *P. contorta*, *P. contorta* var. *Murrayana* (the lodge pole pine) and *P. chihuahuana*. Of *P. muricata* Lemmon says*: "The cones have been known to remain unopened for twenty or thirty years, then to release good seeds," but he says in another place of the cones of the same tree†: "They usually open at the time the leaves at the same point fall away from the stems". The *Gardener's Chronicle* for April 24, 1909 gives a good illustration of this pine showing old unopened cones, and in the same number, Mr. J. W. Bean says: "Some of the trees at Kew bear cones which must have developed more than a quarter of a century ago".

Of the eastern American pines the only ones to retain their cones unopened after maturity are the jack pine (*P. Banksiana*) of the north, the Table Mountain pine (*P. pungens*) of the Alleghanies, the pond pine (*P. serotina*) of the southern states, and *P. clausa* of the gulf coast and eastern Florida. In the case of the last species the cones may become imbedded in the wood as in *P. attenuata*‡.

That this remarkable habit of cone retention is of use in the struggle for existence, at least under the peculiar conditions that exist in our western country, is believed by a number of observers. The explanation that is usually offered is well expressed by John Muir in "Our National Parks" page 104. Speaking of *Pinus attenuata* (under the name of *P. tuberculata*) he says:

"This admirable little tree grows on bushy, sun-beaten slopes, which from their position and the inflamable character of the

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**Handbook of West American Cone-bearers*, 3d ed.

†*Erythea*, Vol. 2, p. 160, 1894.

‡In *Garden and Forest*, Vol. 10, p. 232, Professor C. S. Sargeant remarks that cones of *P. muricata* often become imbedded in the bark, but in a letter to me he says that this "appears to be erroneous".

vegetation are most frequently fire-swept. These grounds it is able to hold against all comers, however big and strong, by saving its seeds until death, when all it has produced are scattered over the bare cleared ground, and a new generation quickly springs out of the ashes."

This statement of Mr. Muir's implies that all or a large part of the seeds produced during the life of the tree are capable of germination when shed, and this seems to be the opinion of others (see Lemmon, as quoted above, under *P. muricata**).

Now it is a well-known fact that pine seeds as a rule are very perishable (seeds of *P. palustris* will not germinate, according to my experience, the second spring after their maturity) and it is important to test by actual experiment to what extent seeds retain their vitality under such conditions. In looking over the literature I can find but one experiment that has been made to enlighten us on this point.

In 1874 Dr. Engleman collected a branch of *Pinus contorta* from Colorado (the plant being probably var. *Murrayana*, or lodge pole pine) and arter keeping it four and a half years, he sent it to Proressor C. S. Sargent, of the Harvard Arboretum, to test the seeds. Professor Sargent planted the seeds in 1879, and his results, as reported in *Bot. Gazette*, Vol. 5, p, 54, 1880, were as follows:

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*The reference to *Pinus radiata* by Vernon Bailey on page 34 of C. Hart Merriam's "Results of a Biological Survey of Mount Shasta, California" (*North American Fauna*, 16, 1899) would indicate that its seeds have a hard time on Mount Shasta He says:

"The trees were loaded with cones, in whorls of three to seven around the branches and down the trunks to 10 or 12 feet from the ground. Some of the cones must have been 20 or 30 years old, and perhaps much older. I cut off a lot of the old lower cones to see if the seed were good, and put them on a boulder and cracked them with a few hard blows of the ax. All of them were full of worm dust, with only now and then an undiscoved seed or a fat white worm. Cones of medium age (5 or 6 years back from the end of the branch) were invariably occupied by worms and worm dust, and usually contained few good seeds. Cones only 1 or 2 years old were rarely wormy. A great many of the old cones had been dug into by woodpeckers, either for seeds or, more likely, for the fat white grubs that live on the seeds."

Seeds of 1865 and 1868 did not germinate.
1869.....24 seeds planted, 4 germinated.
1870.....25 seeds planted, 4 germinated.
1871..... 6 seeds planted, 2 germinated.
1872.....19 seeds planted, 5 germinated.
1873..... 9 seeds planted, none germinated (cones probably not mature.)

This experiment shows that at least some of the seeds of *P. Contorta* (var. *Murrayana?*) are capable of germination after retention in the cones for nine or ten years.

My interest having been aroused in this subject while in California, I was led to observe more closely the cones of our native *P. serotina* on my return to South Carolina and it was soon found that the cones of this species often remain attached and unopen for a much longer time than ever reported. In his "North American Silva," Vol. 3, p. 117, Michaux says: "The cones arrive at maturity the second year, but do not release their seeds before the third or fourth."

Sargent follows this statement in his "Silva" and Britton says (in "North American Trees") that the cones "remain closed for several years before dropping the seed." In the neighborhood of Hartsville, South Carolina, it was not at all uncommon to find cones that had remained unopened for ten or even more years, and the opportunity was taken to collect cones of different ages for a test of the vitality of the seeds. The cones were taken to the New York Botanical Garden and there the test was made in June of this year. Seeds that were obviously blasted or dead (as shown by floating in water) were discarded, and are recorded as "rejected"; only apparently sound seed were planted. The seeds were first germinated between filter paper in *Sphagnum* moss for about five days until the radicals appeared. A count was then made and the results recorded in the columns of June 29 in the table below.‡ All the seeds, whether germinated or not, were then planted in soil in pots, and the seedlings that appeared were coun-

‡Cone No. 1 was not included in this count because its seeds were by mistake planted in soil before the count was taken.

ted on July 12† and July 22, with results as shown in the table below.

Years Old.	Rejected.	Planted.	June 29.	July 12.	July 22.
3	31	32	?	27	28
4	10	14	6	9	9
4	6	15	13	9	9
6	7	57	30	40	39
6	0	62	52	51	52
6	7	60	58	53	48
7	3	88	42	50	44
8	7	49	10	34	33
8	5	27	2	15	18
8	3	42	0	31	33
9	5	34	3	2	0
9	2	31	10	16	7
14	32	61	33	24	21
14	2	67	7	11	11

Increasing numbers in the later readings are due to delayed germinations: decreased numbers to failure to emerge or to damping off after emergence.

It should be noted that the conditions that exist in these serotinous cones are almost ideal for the preservation of the vitality of the seeds. While some exchange of gases is allowed, the spores of fungi and bacteria are effectually excluded; and most important of all, a sufficient humidity is maintained to prevent a fatal dehiscence. That this humidity is due to contact with the moist wood of the live trees is shown by the mechanical opening of the cone through drying when it is removed from the wood, or when the tree dies. This opening, however, is not always either prompt or complete.

Chapel Hill, N. C.

†This counting was, in my absence, kindly made by Mr. Fred. J. Seaver.